Ion gel metal-insulator-semiconductor capacitors based on (Ga,Mn)N

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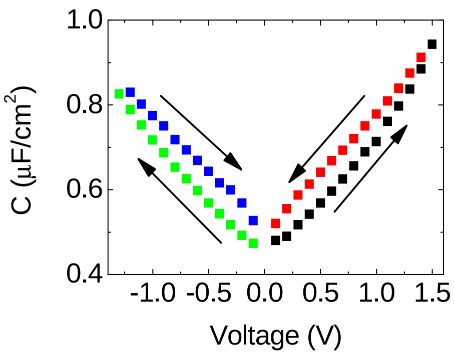
We report fabrication and characterization of metal-insulator-semiconductor (MIS) structures based on (Ga,Mn)N, where the gel electrolyte, a so-called ion gel (IG) is used as the gate dielectrics. An ion gel is a relatively new material, which consist of an ionic liquid immobilized inside a co-polymer network [1]. The main advantages of using IGs stems from their large capacitance (the capacitances can exceed 10 μF/cm^2 as compared to other materials, for example a 100-120 nm thick dielectric layer of HfO_2 exhibiting a capacitance of about 0.1 μF/cm^2). Moreover the ion gel material is easily applied (it can be neatly cut with a razor blade and stick onto semiconducting material), cost effective substance and for example can be used in printed electronics [2].



Capacitance of a typical MIS structure based on p-type GaAs and ion gel at room temperature and f = 1 kHz.

It is well known that by applying an electric field using a MIS structure based on (Ga,Mn)As, the hole concentration and, thereby, the magnetic anisotropy can be easily controlled [3]. It was recently demonstrated that the co-doping with Mg allows to control the Mn^{n+} charge and spin (S) state in the range $3 \leq n \leq 5$ and $2 \geq S \geq 1$ [4]. It might be expected that the same outstanding degree of tunability can be achieved by an electric field. Therefore the successful application of IG may allow to investigate magnetic properties of Au/IG/(Ga,Mn)N/GaN MIS structure under an applied electric field. In this work, we present results for MIS capacitors consisting of IG and either p-type GaAs or (Ga,Mn)N channel, which exhibit a capacitance of about 0.6 μF/cm^2 (see Figure). The devices work well in the temperature range between room temperature down to at least 40 K. Our results indicate that a large charge modulation can be achieved in (Ga,Mn)N. Its effect upon magnetic properties is being searched by SQUID magnetometery.

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